Serial No.: 10/791,096
Group Art Unit: 2813

REMARKS

Claim Rejections - 35 USC §112

The Examiner stated that Claim 2 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 2 has been amended to delete "tungsten nitride" from this dependent claim.

The Examiner has stated:

> "Claim 2 recites the limitation "the tungsten nitride contact liners" on page 11, line 14. There is insufficient antecedent basis for this limitation in the claim."

Regarding claim 2, claim 2 has been amended to delete the language cited by the Examiner in this rejection. Claim 2 now refers to "contact liners" and is no longer believed to be vague and indefinite. Withdrawal of this rejection under 35 U.S.C. §112, second paragraph, is hereby solicited.

Claim Rejections - 35 USC §103

Claims 1-8, 11, 12, 15-17, and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chang (U.S. Patent 6,858,506, hereinafter "Chang") in view of Lim (U.S. 2004/0115929, hereinafter "Lim").

Chang teaches a metal oxide transistor having a strained channel by forming a SiGe layer on the surface of a substrate and then forming a strained silicon layer over the SiGe layer. Chang does not teach the formation of an interlayer dielectric layer having contact holes formed therein, the formation of contact liners, or the formation of contacts.

Lim teaches a method of manufacturing a semiconductor device by forming a tungsten nitride layer in contact holes using an atomic layer deposition method. There is no teaching or suggestion of the formation of a silicide or a thermal budget for the formation of a silicide.

Claim 1 has been clarified to include the limitation not taught or suggested by Chang or Lim, taken either singly or in combination, of:

> "forming a silicide on the source/drain junctions and on the gate within a thermal budget having a temperature dependent upon the silicide metal;
>
> forming contact liners in the contact holes within the thermal budget for forming the silicide"

Support for the Amendment is at page 8, lines 5-7 and page 9, lines 22-24. No new matter has been added.

The Examiner has stated:

> "Chang teaches ... forming a nickel silicide on the source/drain junctions and on the gate (234 in Fig. 2G; column 4, line 56 - column 5, line 10)."

However, Chang states with respect to formation of the silicide at column 4, lines 62-64:

> "After executing an annealing process, for example, at a temperature of about 400 to 800 degrees Celsius for about 20 to 60 seconds..."

Chang is silent with respect to "a thermal budget having a temperature dependent upon the silicide metal", and therefore teaches away from Applicants' invention as claimed.

The Examiner also has stated:

> "Chang does not teach depositing an interlayer dielectric having contact holes therein above the semiconductor substrate; forming contact liners in the contact holes; and forming contacts in the contact holes over the contact liners, whereby the contact liners are formed of a nitride of the material of the contacts."

Applicants agree that Chang fails to teach the formation of an interlayer dielectric layer, any contact holes in the interlayer dielectric, any contact liners of any type in the contact holes, much less at the thermal budget claimed by Applicants. Applicants respectfully submit that Chang teaches away from Applicants invention.

The Examiner also has stated:

> "Therefore, at the time of the invention, it would have been obvious to one of ordinary skill in the art to modify the teachings of Chang by additionally depositing an interlayer dielectric having contact holes therein above the semiconductor substrate; forming contact liners in the contact holes; and forming contacts in the contact holes over the contact liners, whereby the

> contact liners are formed of tungsten nitride and the contacts are formed of tungsten, as taught by Lim. The motivation for doing so at the time of the invention would have been that the method taught by Lim simplifies a deposition process of a tungsten nitride layer as a barrier metal, as expressly taught by Lim (paragraph 0014)."

However, Lim is silent with respect to the formation of any silicide much less within the thermal budget claimed by Applicants. Accordingly, it is respectfully submitted that Lim fails to teach or suggest Applicants invention as claimed in independent claim 1.

Applicants respectfully submit that:

> "[T]he prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure." *In re* Vaeck, 947 F2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991)

Also, since Lim fails to recognize the problem of forming contact liners in semiconductors having silicide layers, it is submitted that the proposed combination of Chang and Lim is inappropriate and without foundation because where there is a specific hint or suggestion in a particular reference, but the references as a whole teach away from each other, the combination cannot be obvious according to the CAFC:

> "We have noted elsewhere, as a "useful general rule," that references that teach away cannot serve to create a prima facie case of obviousness... If references taken in combination would produce a "seemingly inoperative device", we have held that such references teach away from the combination and thus cannot serve as predicates for a prima facia case of obviousness." *In re* Gordon, 733 F.2d 900, 902, 221 USPQ 1125, 1127 (Fed. Cir. 1984)[deletion for clarity]

Allowance of claim 1 is hereby solicited.

With regard to claims 2 and 4-5, claims 2 and 4-5, depend upon claim 1 and are believed to be allowable for the reasons set forth above with regard to claim 1 since they contain all the limitations set forth in the independent claim from which they depend and claim non-obvious combinations thereof because of *In re* Vaeck, *supra* and *In re* Gordon, *supra*.

With regard to claim 6, claim 6 has been clarified to include the limitation not taught or suggested by Chang or Lim, taken either singly or in combination, of:

> "forming a nickel silicide on the source/drain junctions and on the gate within a thermal budget having a temperature of less than about 400 degrees centigrade;
>
> forming tungsten nitride contact liners in the contact holes within the thermal budget for forming the nickel silicide"

Support for this amendment is at page 9, lines 22-24 and claim 8 as originally filed. No new matter has been added.

The Examiner has stated:

> "Regarding claims 6 and 17, Chang teaches a method of forming an integrated circuit comprising providing a semiconductor substrate (200 in Fig. 2D); forming a gate dielectric on the semiconductor substrate (206 in Fig. 2D; column 3, lines 36-39); forming a gate on the gate dielectric (208 in Fig. 2D; column 3, lines 46-47); forming source/drain junctions in the semiconductor substrate (210 in Fig. 2D; column 3, line 59-column 4, line 39); and forming a nickel silicide on the source/drain junctions and on the gate (234 in Fig. 2G; column 4, line 56 - column 5, line 10)."

However, Chang states with respect to formation of the silicide at column 4, lines 62-64:

> "After executing an annealing process, for example, at a temperature of about 400 to 800 degrees Celsius for about 20 to 60 seconds..."

Chang therefore teaches formation of a silicide having a temperature higher than that claimed by Applicants, and consequently teaches away from Applicant invention.

The Examiner also stated:

> "Chang does not teach depositing an interlayer dielectric having contact holes therein above the semiconductor substrate; forming tungsten nitride contact liners in the contact holes; and forming tungsten contacts in the contact holes over the contact liners."

Applicants agree that Chang fails to teach the formation of an interlayer dielectric layer, any contact holes in the interlayer dielectric, any contact liners of any type in the contact holes, much less at the thermal budget claimed by Applicants. Applicants respectfully submit that Chang teaches away from Applicants invention.

The Examiner also has stated:

> "Therefore, at the time of the invention, it would have been obvious to one of ordinary skill in the art to modify the teachings of Chang by additionally depositing an interlayer dielectric having contact holes therein above the semiconductor substrate; forming tungsten nitride contact liners in the contact holes; and forming tungsten contacts in the contact holes over the contact liners, as taught by Lim. The motivation for doing so at the time of the invention would have been that the method taught by Lim simplifies a deposition process of a tungsten nitride layer as a barrier metal, as expressly taught by Lim (paragraph 0014)."

However, Lim is silent with respect to the formation of any silicide much less within the thermal budget claimed by Applicants. Accordingly, it is respectfully submitted that Lim fails to teach or suggest Applicants invention as claimed in independent claim 1.

Applicants respectfully submit that claim 6 is allowable over Chang in view of Lim taken either singly or in combination because of *In re* Vaeck, *supra* and *In re* Gordon, *supra*.

With regard to claim 7, claim 7 depends upon claim 6 and is believed to be allowable for the reasons set forth above with regard to claim 6 since it contains all the limitations set forth in the independent claim from which it depends and claims non-obvious combinations thereof because of *In re* Vaeck, *supra* and *In re* Gordon, *supra*.

With regard to claim 11, claim 11 has been clarified to include the limitation not taught or suggested by Chang or Lim, taken either singly or in combination, of:

> "an ultra-thin silicide on the source/drain junctions and on the gate"

With respect to claim 11, the Examiner has stated the same rejection with regard to claim 1 above.

However, Chang is silent with respect to the thickness of the silicide (see for example, column 4, lines 56-67). Also as stated above Lim is silent with respect to the formation of any silicide much less an ultra-thin silicide as claimed by Applicants.

Accordingly, Applicants submit that claim 11 is allowable over Chang in view of Lim taken either singly or in combination because of In re Vaeck, supra and In re Gordon, supra.

With regard to claims 12, 15, and 16, claims 12, 15, and 16 depend upon claim 11 and are believed to be allowable for the reasons set forth above with regard to claim 11 since they contain all the limitations set forth in the independent claim from which they depend and claim non-obvious combinations thereof because of *In re* Vaeck, *supra* and *In re* Gordon, *supra*.

With regard to claim 17, claim 17 has been clarified to include the limitation not taught or suggested by Chang or Lim, taken either singly or in combination, of:

"an ultra-thin thickness of a nickel silicide on the source/drain junctions and on the gate"

With respect to claim 17, the Examiner has stated the same rejection with regard to claim 6 above.

However, Chang is silent with respect to the thickness of the silicide (see for example, column 4, lines 56-67). Also as stated above Lim is silent with respect to the formation of any silicide much less an ultra-thin silicide as claimed by Applicants.

Accordingly, Applicants submit that claim 17 is allowable over Chang in view of Lim taken either singly or in combination because of *In re* Vaeck, *supra* and *In re* Gordon, *supra*.

With regard to claim 20, claim 20 depends upon claim 17 and is believed to be allowable for the reasons set forth above with regard to claim 17 since it contains all the limitations set forth in the independent claim from which it depends and claims non-obvious combinations thereof because of *In re* Vaeck, *supra* and *In re* Gordon, *supra*.

Claims 9, 13, and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chang (U.S. 6,858,506, hereinafter "Chang") in view of Lim (U.S. 2004/0115929, hereinafter "Lim") as applied to claims 6, 11, and 17 above, and further in view of Tseng (U.S. 2005/0035460, hereinafter "Tseng").

With regard to claims 9, 13, and 18, claims 9, 13, and 18 depend respectively upon independent claims 6, 11, and 17 and are believed to be allowable for the reasons set forth above with regard to claims 6, 11, and 17 since they contain all the limitations set forth

in the independent claim from which they depend and claim non-obvious combinations thereof because of *In re* Vaeck, *supra* and *In re* Gordon, *supra*.

The Examiner has stated:

> "Regarding claims 9, 13, and 18, Chang and Lim together teach the method of claim 6 and the device of claims 11 and 17 (note 35 U.S.C. 103(a) rejections above). They do not teach that forming the nickel silicide uses an ultra-thin thickness of a nickel silicide.

Applicants agree that Chang and Lim, taken either singly or in combination, fail to teach or suggest forming an ultra-thin nickel silicide.

The Examiner also stated:

> "Tseng teaches forming nickel silicide layers with a thickness of 50 - 350 Å (paragraph 0037), within the limits indicated in the instant specification on page 8, line 4 of "not more than 50 Å thickness."

However, Tseng specifically states at paragraph [0037]:

> "The metal silicides ... preferably have a thickness between about 50 Å and 350 Å." [deletions and underlining for clarity]

Applicants submit that the teaching of silicides having a thickness greater than the claimed thickness actually teaches away from Applicants' invention.

Accordingly, Applicants submit that the Examiner's proposed combination of Chang, Lim and Tseng is improper because of *In re* Vaeck, *supra* and *In re* Gordon, *supra*.

Allowance of claims 9, 13, and 18 is hereby solicited.

Claims 10, 14, and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chang (U.S. 6,858,506, hereinafter "Chang") in view of Lim (U.S. 2004/0115929, hereinafter "Lim") as applied to claims 6, 11, and 17 above, and further in view of Tseng (U.S. 2005/0035460, hereinafter "Tseng") and Wolf et al. (Silicon Processing for the VLSI Era, Vol. 1, hereinafter "Wolf").

With regard to claims 10, 14, and 19, claims 10, 14, and 19 depend respectively upon independent claims 6, 11, and 17 and are believed to be allowable for the reasons set forth above with regard to claims 6, 11, and 17 since they contain all the limitations set forth in the independent claim from which they depend and claim non-obvious combinations thereof because of *In re* Vaeck, *supra* and *In re* Gordon, *supra*.

Allowance of claims 10, 14, and 19 is hereby solicited.

Serial No.: 10/791,096
Group Art Unit: 2813

Other

The Examiner stated that the prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Applicants submit that the pending claims are allowable over the references cited as well those not relied upon by the Examiner whether taken singly or in combination.

Conclusion

In view of the above, it is submitted that the pending claims are in condition for allowance and reconsideration of the rejections is respectfully requested. Allowance of claims 1-2, 4-7, 9-12, 14-17, 19, and 20 at an early date is solicited.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including any extension of time fees, to Deposit Account No. 01-0365 and please credit any excess fees to such deposit account.

Respectfully submitted,

Mikio Ishimaru

Mikio Ishimaru
Registration No. 27,449

The Law Offices of Mikio Ishimaru
1110 Sunnyvale-Saratoga Rd., Suite A1
Sunnyvale, CA 94087
Telephone: (408) 738-0592
Fax: (408) 738-0881
Date: October 11, 2005